

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A process for obtaining a hydrogen product from a feed gas, wherein the feed  
5 gas is comprised of hydrogen sulfide, comprising the following steps:
  - (a) first separating the feed gas to obtain a first purified hydrogen sulfide fraction  
10 from the feed gas, wherein the first purified hydrogen sulfide fraction is comprised of at least about 90 percent hydrogen sulfide by volume;
  - (b) dissociating hydrogen sulfide present in the first purified hydrogen sulfide  
15 fraction into elemental hydrogen and elemental sulfur to convert the first purified hydrogen sulfide fraction into a dissociated first purified hydrogen sulfide fraction, wherein the dissociated first purified hydrogen sulfide fraction is comprised of elemental hydrogen and elemental sulfur;
  - (c) second separating the dissociated first purified hydrogen sulfide fraction to  
20 obtain a hydrogen rich fraction from the dissociated first purified hydrogen sulfide fraction, wherein the hydrogen rich fraction is comprised of elemental hydrogen; and
  - (d) obtaining the hydrogen product from the hydrogen rich fraction, wherein the  
hydrogen product is comprised of elemental hydrogen.
- 25 2. The process as claimed in claim 1 wherein the dissociating step is comprised of dissociating hydrogen sulfide present in the first purified hydrogen sulfide fraction by thermal decomposition.
3. The process as claimed in claim 2 wherein the dissociating step is performed at a  
30 temperature of between about 1500 degrees Celsius and about 2000 degrees Celsius.

4. The process as claimed in claim 3 wherein the dissociating step is performed at a pressure of between about 200 kilopascals and about 500 kilopascals.
- 5 5. The process as claimed in claim 1 wherein the dissociating step is comprised of dissociating hydrogen sulfide present in the first purified hydrogen sulfide fraction by thermal decomposition under plasma conditions.
6. The process as claimed in claim 5 wherein the dissociating step is performed at a  
10 temperature of between about 1500 degrees Celsius and about 2000 degrees Celsius.
7. The process as claimed in claim 6 wherein the dissociating step is performed at a pressure of between about 200 kilopascals and about 500 kilopascals.
- 15 8. The process as claimed in claim 1 wherein the dissociating step is performed in a plasma reactor.
9. The process as claimed in claim 8 wherein the plasma reactor is driven by electromagnetic energy.  
20
10. The process as claimed in claim 9 wherein the electromagnetic energy is comprised of microwave energy.
11. The process as claimed in claim 10 wherein the dissociating step is performed at  
25 a temperature of between about 1500 degrees Celsius and about 2000 degrees Celsius.
12. The process as claimed in claim 11 wherein the dissociating step is performed at a pressure of between about 200 kilopascals and about 500 kilopascals.
- 30 13. The process as claimed in claim 1 wherein the first separating step is comprised of the step of passing the feed gas through an amine based reagent which is capable of

selectively absorbing hydrogen sulfide so that the first purified hydrogen sulfide fraction is absorbed by the amine based reagent.

14. The process as claimed in claim 13 wherein the amine based reagent is  
5 comprised of a Flexsorb<sup>TM</sup> amine based reagent.

15. The process as claimed in claim 13 wherein the first separating step is further  
comprised of the step of regenerating the amine based reagent from the first purified hydrogen  
sulfide fraction to recover the amine based reagent from the first purified hydrogen sulfide  
10 fraction.

16. The process as claimed in claim 1 wherein the hydrogen rich fraction is further  
comprised of hydrogen sulfide and wherein the hydrogen product obtaining step is comprised of  
the step of third separating the hydrogen rich fraction to obtain the hydrogen product from the  
15 hydrogen rich fraction.

17. The process as claimed in claim 16 wherein the third separating step is  
comprised of the step of passing the hydrogen rich fraction through an amine based reagent  
which is capable of selectively absorbing hydrogen sulfide to obtain a third purified hydrogen  
20 sulfide fraction, wherein the third purified hydrogen sulfide fraction is comprised of hydrogen  
sulfide and wherein the third purified hydrogen sulfide fraction is absorbed by the amine based  
reagent.

18. The process as claimed in claim 17 wherein the amine based reagent is  
25 comprised of a Flexsorb<sup>TM</sup> amine based reagent.

19. The process as claimed in claim 17 wherein the third separating step is further  
comprised of the step of regenerating the amine based reagent from the third purified hydrogen  
sulfide fraction to recover the amine based reagent from the third purified hydrogen sulfide  
30 fraction.

20. The process as claimed in claim 19, further comprising the step of combining the third purified hydrogen sulfide fraction with the first purified hydrogen sulfide fraction.

21. The process as claimed in claim 17 wherein the first separating step is comprised  
5 of the step of passing the feed gas through an amine based reagent which is capable of selectively absorbing hydrogen sulfide so that the first purified hydrogen sulfide fraction is absorbed by the amine based reagent.

22. The process as claimed in claim 21 wherein the amine based reagent is  
10 comprised of a Flexsorb<sup>TM</sup> amine based reagent.

23. The process as claimed in claim 21, further comprising the step of combining the third purified hydrogen sulfide fraction with the first purified hydrogen sulfide fraction.

15 24. The process as claimed in claim 23, further comprising the step of regenerating the amine based reagent from the first purified hydrogen sulfide fraction and the third purified hydrogen sulfide fraction to recover the amine based reagent from the first purified hydrogen sulfide fraction and the third purified hydrogen sulfide fraction.

20 25. The process as claimed in claim 1 wherein the dissociated first purified hydrogen sulfide fraction is further comprised of hydrogen sulfide and wherein the second separating step is further comprised of obtaining a second purified hydrogen sulfide fraction from the dissociated first purified hydrogen sulfide fraction, wherein the second purified hydrogen sulfide fraction is comprised of hydrogen sulfide.

25 26. The process as claimed in claim 25 wherein the second purified hydrogen sulfide fraction is obtained by centrifugally separating the dissociated first purified hydrogen sulfide fraction.

27. The process as claimed in claim 25 wherein the second purified hydrogen sulfide fraction is obtained by gravitationally separating the dissociated first purified hydrogen sulfide fraction.

5 28. The process as claimed in claim 25, further comprising the step of combining the second purified hydrogen sulfide fraction with the first purified hydrogen sulfide fraction.

29. The process as claimed in claim 1, further comprising the step of cooling the dissociated first purified hydrogen sulfide fraction following the dissociating step in order to  
10 inhibit recombination of the elemental hydrogen and the elemental sulfur.

30. The process as claimed in claim 29 wherein the cooling step is performed immediately following the dissociating step.

15 31. The process as claimed in claim 29 wherein the cooling step is comprised of cooling the dissociated first purified hydrogen sulfide fraction to a temperature of less than about the boiling point of the elemental sulfur.

32. The process as claimed in claim 31 wherein the cooling step is performed  
20 immediately following the dissociating step.

32. The process as claimed in claim 29, further comprising the step of obtaining a sulfur product from the dissociated first purified hydrogen sulfide fraction, wherein the sulfur product is comprised of elemental sulfur.

25 33. The process as claimed in claim 1, further comprising the step of delivering the hydrogen product to a fuel cell in order to produce electrical energy from the hydrogen product.

34. The process as claimed in claim 33, further comprising the step of using in the  
30 dissociating step the electrical energy produced by the fuel cell.

35. An apparatus for obtaining a hydrogen product from a feed gas, wherein the feed gas is comprised of hydrogen sulfide, the apparatus comprising:

5 (a) a first separating apparatus for first separating the feed gas to obtain a first purified hydrogen sulfide fraction from the feed gas such that the first purified hydrogen sulfide fraction is comprised of at least about 90 percent hydrogen sulfide by volume;

10 (b) a dissociating apparatus for dissociating hydrogen sulfide present in the first purified hydrogen sulfide fraction into elemental hydrogen and elemental sulfur to convert the first purified hydrogen sulfide fraction into a dissociated first purified hydrogen sulfide fraction, wherein the dissociated first purified hydrogen sulfide fraction is comprised of elemental hydrogen and elemental sulfur;

15 (c) a second separating apparatus for second separating the dissociated first purified hydrogen sulfide fraction to obtain a hydrogen rich fraction from the dissociated first purified hydrogen sulfide fraction, wherein the hydrogen rich fraction is comprised of elemental hydrogen; and

20 (d) a third separating apparatus for third separating the hydrogen rich fraction to obtain the hydrogen product from the hydrogen rich fraction, wherein the hydrogen product is comprised of elemental hydrogen.

25 36. The apparatus as claimed in claim 35 wherein the dissociating apparatus is comprised of a plasma reactor.

30 37. The apparatus as claimed in claim 36 wherein the plasma reactor is driven by electromagnetic energy.

38. The apparatus as claimed in claim 37 wherein the electromagnetic energy is comprised of microwave energy.

39. The apparatus as claimed in claim 38 wherein the plasma reactor is capable of providing an operating temperature of between about 1500 degrees Celsius and about 2000 degrees Celsius.

40. The apparatus as claimed in claim 35 wherein the first separating apparatus is comprised of at least one absorber vessel.

41. The apparatus as claimed in claim 40 wherein the first separating apparatus is further comprised of an amine based reagent which is capable of selectively absorbing hydrogen sulfide so that the first purified hydrogen sulfide fraction is absorbed by the amine based reagent.

42. The apparatus as claimed in claim 41 wherein the amine based reagent is comprised of a Flexsorb<sup>TM</sup> amine based reagent.

43. The apparatus as claimed in claim 41 wherein the first separating apparatus is further comprised of a regenerator for recovering the amine based reagent from the first purified hydrogen sulfide fraction.

44. The apparatus as claimed in claim 43 wherein the regenerator is in communication with both of the absorber vessel and the dissociating apparatus so that the first purified hydrogen sulfide fraction passes from the absorber vessel to the regenerator and from the regenerator to the dissociating apparatus.

45. The apparatus as claimed in claim 35 wherein the second separating apparatus is comprised of a second separating apparatus heat exchanger for cooling the dissociated first purified hydrogen sulfide fraction in order to inhibit recombination of the elemental hydrogen and the elemental sulfur.

46. The apparatus as claimed in claim 45 wherein the second separating apparatus is further comprised of a sulfur collector for collecting a sulfur product.
- 5 47. The apparatus as claimed in claim 46 wherein the sulfur collector is comprised of a sulfur outlet.
48. The apparatus as claimed in claim 46 wherein the second separating apparatus is further comprised of an outlet for the hydrogen rich fraction.
- 10 49. The apparatus as claimed in claim 48 wherein the second separating apparatus is further comprised of a separator for obtaining a second purified hydrogen sulfide fraction from the dissociated first purified hydrogen sulfide fraction.
- 15 50. The apparatus as claimed in claim 49 wherein the second separating apparatus is further comprised of an outlet for the second purified hydrogen sulfide fraction.
51. The apparatus as claimed in claim 50 wherein the outlet for the second purified hydrogen sulfide fraction is in communication with the dissociating apparatus so that the
- 20 second purified hydrogen sulfide fraction is dissociated by the dissociating apparatus.
52. The apparatus as claimed in claim 35 wherein the third separating apparatus is comprised of at least one absorber vessel.
- 25 53. The apparatus as claimed in claim 52 wherein the third separating apparatus is further comprised of an amine based reagent which is capable of selectively absorbing hydrogen sulfide so that a third purified hydrogen sulfide fraction is absorbed by the amine based reagent.
54. The apparatus as claimed in claim 53 wherein the amine based reagent is
- 30 comprised of a Flexsorb<sup>TM</sup> amine based reagent.



55. The apparatus as claimed in claim 53 wherein the third separating apparatus is further comprised of a regenerator for recovering the amine based reagent from the third purified hydrogen sulfide fraction.

5 56. The apparatus as claimed in claim 55 wherein the regenerator is in communication with both of the absorber vessel and the dissociating apparatus so that the third purified hydrogen sulfide fraction passes from the absorber vessel to the regenerator and from the regenerator to the dissociating apparatus.

10 57. The apparatus as claimed in claim 53 wherein the first separating apparatus is comprised of at least one absorber vessel.

58. The apparatus as claimed in claim 57 wherein the first separating apparatus is further comprised of an amine based reagent which is capable of selectively absorbing hydrogen  
15 sulfide so that the first purified hydrogen sulfide fraction is absorbed by the amine based reagent.

59. The apparatus as claimed in claim 58 wherein the amine based reagent is comprised of a Flexsorb<sup>TM</sup> amine based reagent.

20 60. The apparatus as claimed in claim 58, further comprising a regenerator for recovering the amine based reagent from the first purified hydrogen sulfide fraction and the third purified hydrogen sulfide fraction.

25 61. The apparatus as claimed in claim 60 wherein the regenerator is in communication with each of the first separating apparatus, the third separating apparatus and the dissociating apparatus so that the first purified hydrogen sulfide fraction and the third purified hydrogen sulfide fraction pass from the first separating apparatus and the third separating apparatus to the regenerator and from the regenerator to the dissociating apparatus.

30

62. The apparatus as claimed in claim 61 wherein the regenerator is comprised of a regenerator heat exchanger for heating the first purified hydrogen sulfide fraction and the third purified hydrogen sulfide fraction.

5 63. The apparatus as claimed in claim 62 wherein the second separating apparatus is comprised of a second separating apparatus heat exchanger for cooling the dissociated first purified hydrogen sulfide fraction in order to inhibit recombination of the elemental hydrogen and the elemental sulfur.

10 64. The apparatus as claimed in claim 63 wherein the regenerator heat exchanger and the second separating apparatus heat exchanger are associated such that heat from the second separating apparatus is transferred to the regenerator.

15 65. The apparatus as claimed in claim 35, further comprising a fuel cell for producing electrical energy from the hydrogen product.

66. The apparatus as claimed in claim 65 wherein the fuel cell is electrically connected with the dissociating apparatus so that the electrical energy is used to power the dissociating apparatus.

20